SOUND IDEAS ON NOISE ABATEMENT

The Massachusetts Port Authority

A Report on Noise Abatement

Keeping the noise down.

More than ten years have passed since the adoption of the Federal Airline Deregulation Act. Since then, Logan Airport has witnessed dramatic increases in operations, passengers, and cargo. The number of passengers has more than doubled since 1978—more than 23.4 million in 1988—and the volume of cargo has increased by 75.6 percent.

But remarkably, noise didn't go up.

Massport has well-defined views on how to run an airport responsibly, especially one so close to people's homes and schools. We believe in being a good neighbor, and in doing more than the minimum in easing the noise burden.

In the pages that follow, you'll learn how we've kept noise levels down through initiatives such as:

- Noise rules which encourage airlines to use quieter planes;
- Soundproofing of homes and schools;
- Noise monitoring in the communities around Logan.

We realize that for all the work we do to control noise at Logan, the simple truth is that airplanes make noise. But through the implementation of sound ideas and programs, Massport is keeping the noise down.

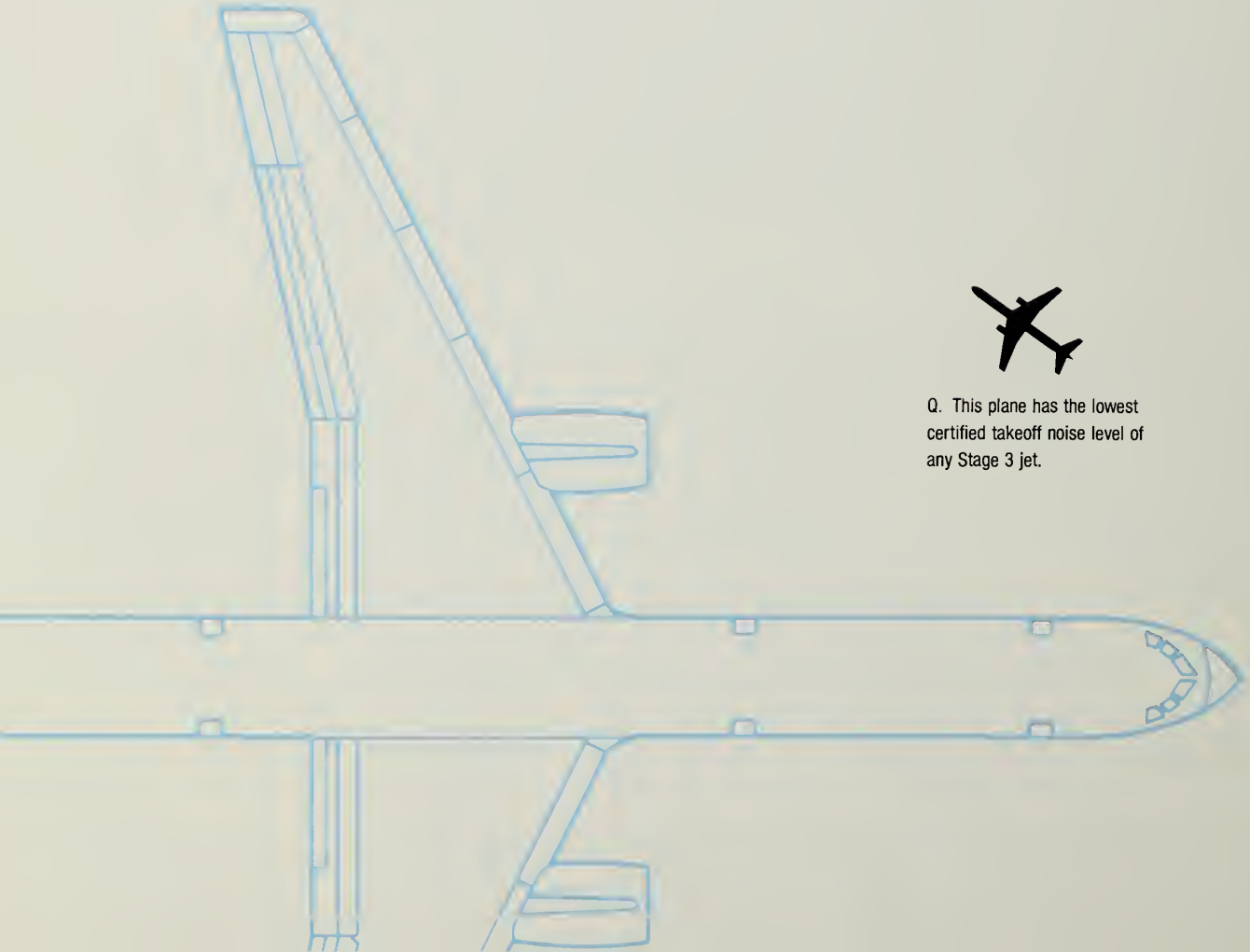
David W. Davis
Executive Director, Massport

The History.
Putting a Lid on It.

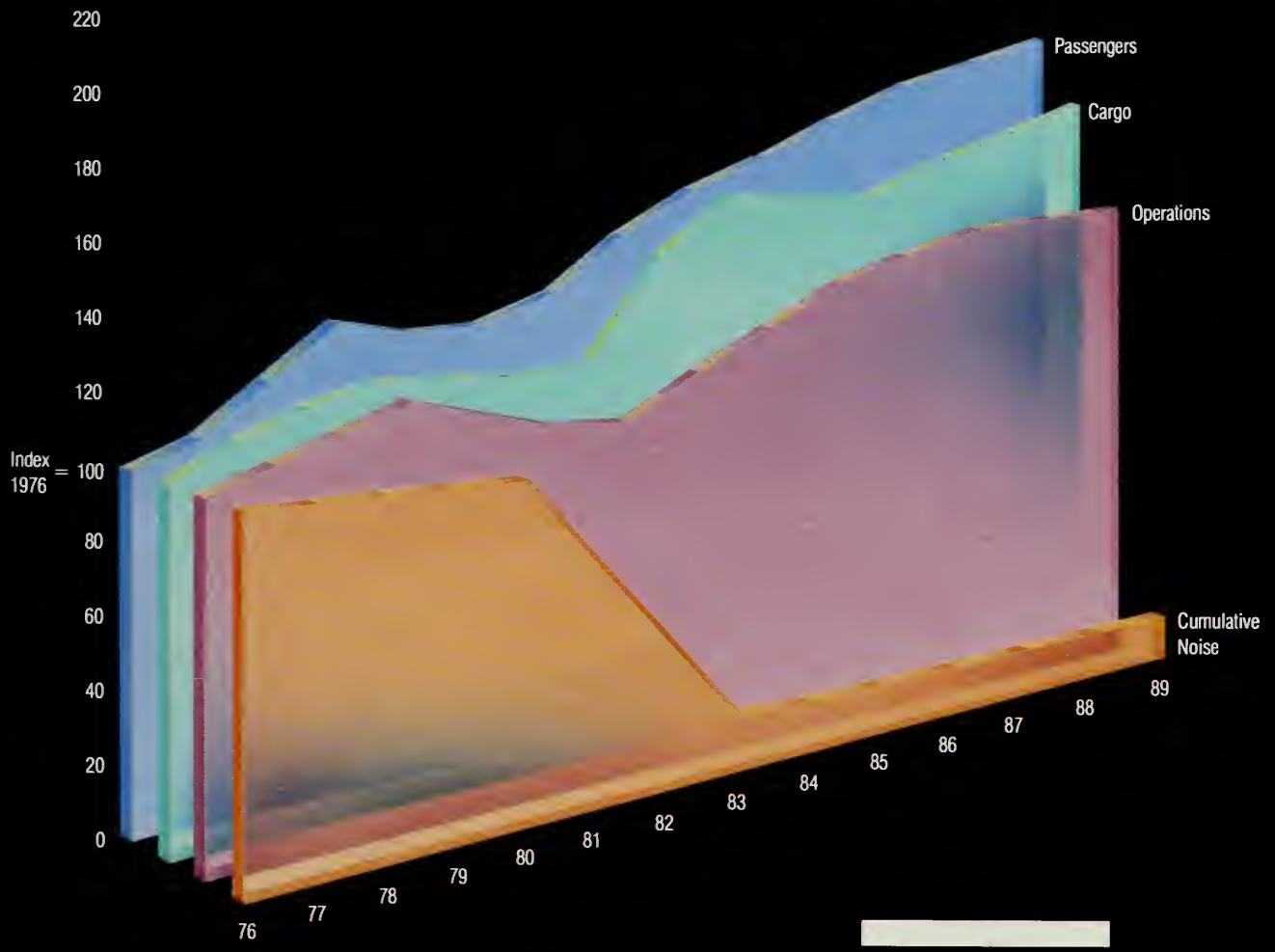
Logan Airport has an unusual dilemma. It's situated within the City of Boston and bordered on three sides by densely populated residential neighborhoods. Hundreds of thousands of people are affected by Logan's day-to-day operations. And while Massport recognizes that Logan must continue to meet regional transportation demands, it also recognizes its responsibility to the airport's neighbors.

In 1976, the Massport Board adopted Logan's first noise rules and they remained effective, with some adjustments in 1980, for nearly a decade. Over time, however, due to the development of newer airplane engines, many of those rules became outdated.

Although the Airline Deregulation Act was passed in 1978, real growth in the airline industry came slowly, so that between 1978 and 1984 noise levels at Logan actually decreased. The major reason for this decline was the gradual introduction by major airlines of newer, quieter airplanes combined with the phased elimination of their oldest, noisiest planes (known as Stage 1 aircraft). Welcome as these changes were, continued growth in the airline industry was inevitable, and Massport recognized that a ten year trend of noise reduction could be reversed. Therefore, in 1986 stricter noise rules were implemented by Massport and a lid was placed on noise levels at Logan Airport. In creating this noise cap, 1984 was chosen as the base year so that none of the previously achieved benefits was lost.



Q. This plane has the lowest certified takeoff noise level of any Stage 3 jet.



Comparative Trends Chart

The chart compares trends in airport operations, passengers, cargo tonnage and cumulative noise from 1976, the first year of the Logan noise rules, to the present. Each of the values was indexed to 1976 with 1976 equaling 100. The cumulative noise value was indexed based on total noise energy.

The chart shows that while operations, passengers, and cargo have grown during the period, cumulative noise has dropped and has remained relatively stable since 1984.

Q. Why was December 31, 1987 an important night at Logan?

The Rules.
The principal aim of the Logan noise rules is to keep cumulative noise at or below the 1984 cap level, regardless of fluctuations in the number of passengers and operations.

The Federal Aviation Administration (FAA) classifies aircraft into three noise categories: Stage 1, 2, and 3, with Stage 3 being the quietest and most modern.

The noise rules are designed to modify the mix of Stage 2 and 3 operations at Logan in a manner that increases the number of quieter planes at Logan. The rules entirely eliminated the oldest and noisiest Stage 1 aircraft in January, 1988.

How they Work.
Airlines have the option of complying with two standards— either a Stage 3 percentage or a Noise Per Seat Index (NPSI).

Each year on July 1, Massport determines the Stage 3 percentage and the NPSI that airlines must meet during the upcoming year. The compliance levels are set based on projected growth in operations and changes in airline fleets.

Carriers must choose to comply with one of the two standards and may balance their fleets accordingly.

Stage 3 Percentage.
There are only two ways an airplane can become Stage 3: an airplane is built that way or converted by being retrofitted with new and quieter engines.

When the rules were adopted in 1986, Massport said a carrier had to operate 43.9 percent of its flights at Logan in Stage 3 aircraft in order to be in compliance. By 1989, this requirement was raised to 53.4 percent.

Noise Per Seat Index (NPSI).
NPSI is a calculation which divides the noise level of an aircraft by its number of passenger seats.

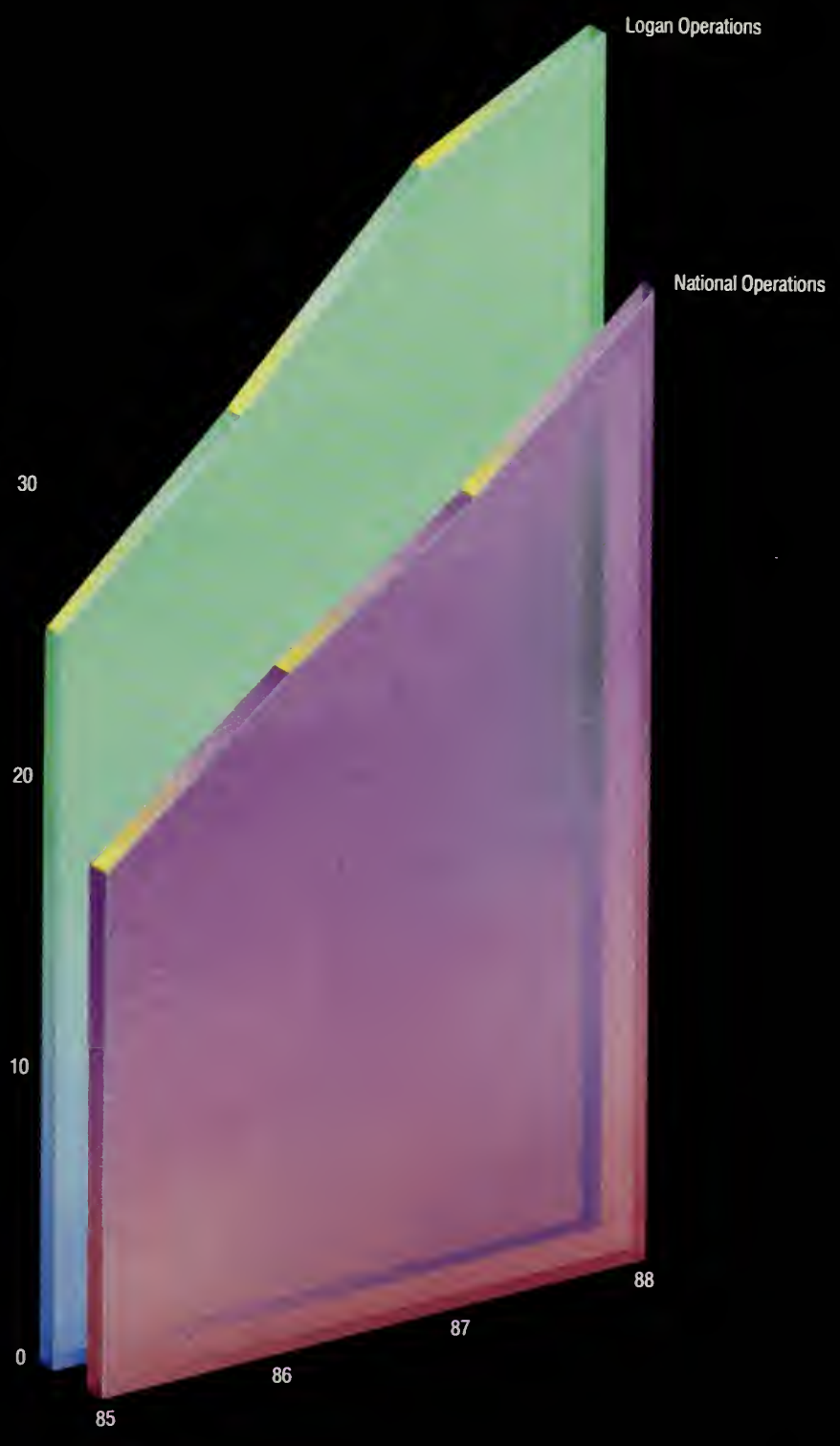
The noise values for each aircraft are specifically defined by airplane series, engine type, maximum certified weights, and other FAA standards. The NPSI encourages airlines to operate larger and quieter planes, thereby carrying more passengers per noise event.

Allowable Stage 2 Operations.
If a carrier cannot comply with either the Stage 3 percentage or the NPSI, it is then capped at its previous number of Stage 2 operations and can only grow if Stage 3 aircraft are added.

Whether jumbo jets, shuttle buses, or MBTA mass transit, Massport believes that the best way to accommodate growth is to move the largest number of people in the fewest possible moves.

Logan Stage 3 vs National Fleet

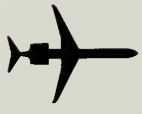
The chart compares the percentage of Stage 3 flights at Logan to the percentage of Stage 3 flights nationwide. The chart indicates that Logan continues to have a higher rate of Stage 3 flights relative to the national average.



Quiet at Night.
Another important aspect of Massport's noise abatement program is the nighttime noise rule. This rule was also revised, and as of January 1, 1988, only Stage 3 planes or aircraft of equivalent noise levels may operate at Logan between 11:00 p.m. and 6:45 a.m. Other aircraft are forbidden during these "quiet hours," with the exception of certain preexisting all-cargo flights. If a non-Stage 3 airplane uses Logan in violation of the rules during these "quiet hours," the carrier is brought to court. Between 1987 and 1989, carriers who violated the rules were fined more than $100,000.

The Results.
The rules are making a big difference. Consider the fleet characteristics for 1988 in regard to Stage 3 operations.

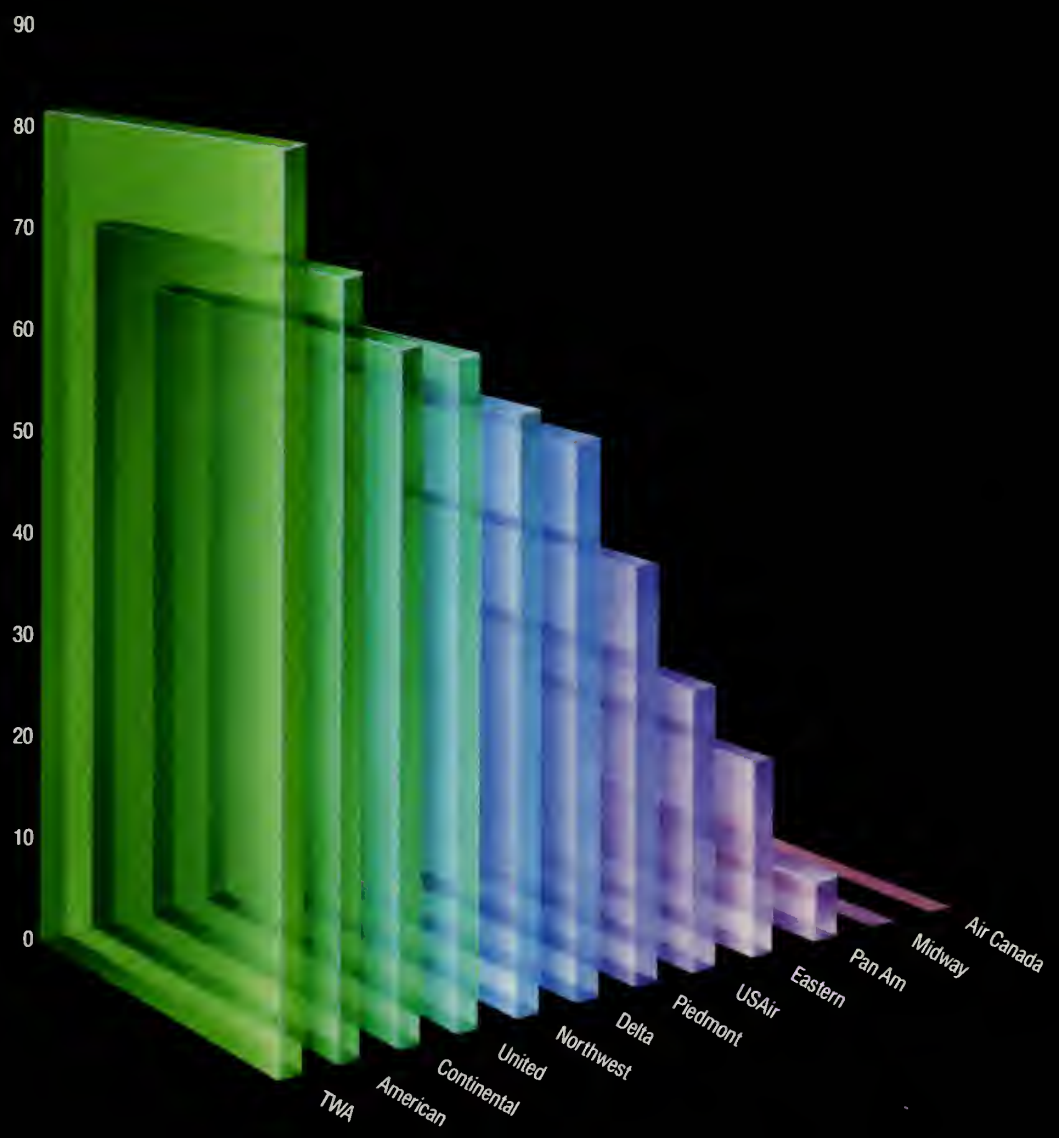
- Logan's Stage 3 share was 40.9 percent, a 10 point increase over 1986.
- Logan's Stage 3 share was 8 points better than the national average of 33 percent.
- Logan's growth in flights since 1986 came exclusively in Stage 3 equipment.
- In addition, noisier Stage 2 flights declined at Logan for the first time this decade, falling 14 percent over the last two years.



Q. What aircraft has the lowest average Noise Per Seat Index at Logan?

Stage 3 Share by Airline

The chart ranks the Logan carriers based on the percentage of Stage 3 operations each carrier conducted in June, 1988.



Q. What is the most common Stage 3 aircraft at Logan?

Quiet in the Classroom.
Massport has the most extensive soundproofing program in the country. Twenty-seven schools have been soundproofed as of the summer of 1989. Pending further FAA funding, five additional schools will be sound insulated in 1990.

In 1981 with support from the FAA, Massport was awarded a first-of-its-kind grant to soundproof a school. East Boston High School was chosen because jet aircraft passed so close students and teachers could read the aircrafts' tail numbers. The school, located less than a mile from the airport, is set on an eighty foot hill in line with Logan's runway 15/33. Roughly 42 percent of the runway's operations occurred during school hours, causing so many interruptions that 17 percent of the school day was lost when the runway was in heavy use.

School Soundproofing.
The successful East Boston High School model was followed in other schools. Large, old windows were replaced with smaller, state-of-the-art interior windows and Lexan storm windows. On average, noise in the classrooms was reduced by nearly 75 percent.

Today, classrooms are significantly quieter. That means a better environment for learning.

The program has been so successful the FAA established a permanent program of financial assistance for school soundproofing to airports nationwide.

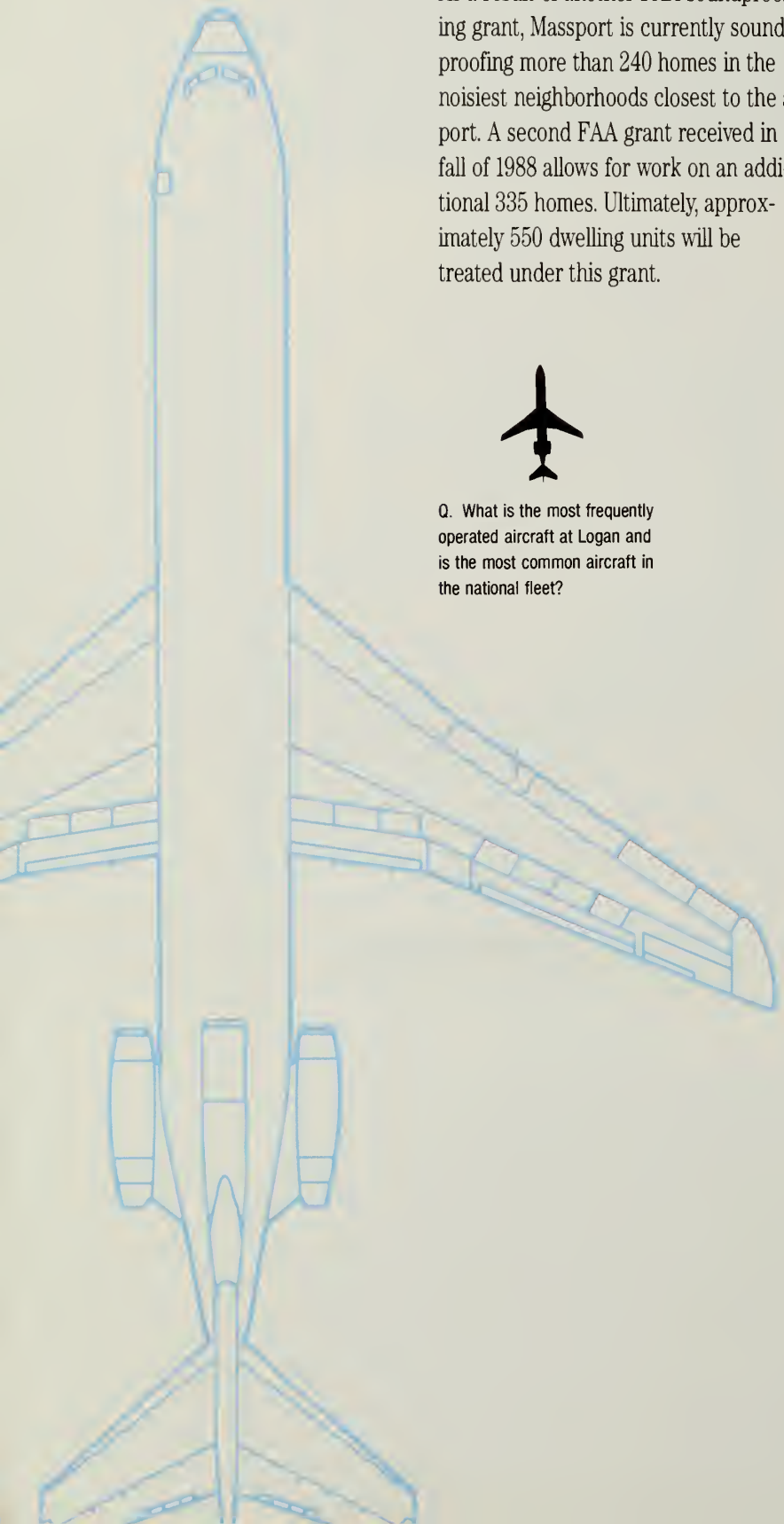
Thanks to the Massachusetts Congressional Delegation.
In 1987 U.S. Senator John Kerry, a member of the Congressional Subcommittee on Aviation, saw to it that Massport's school and residential soundproofing program didn't die. He inserted language in a Senate bill which continued federal noise abatement funding to Massport that otherwise would have been cut off.

Special thanks also go to Massachusetts Congressmen Joseph Kennedy, Joseph Moakley, and Edward Markey, all of whom worked to see that Senator Kerry's bill was approved in the House.

These legislators have the gratitude of both Massport and the thousands of school children and teachers who have benefitted from school soundproofing.

Location of Sound Insulated Schools

The map shows the location of the twenty-seven schools that have been treated by Massport as part of the School Sound Insulation Program by the end of 1989.



Peace and Quiet at Home.
The benefits of soundproofing are also being extended to homes close to Logan. As a result of another FAA soundproofing grant, Massport is currently soundproofing more than 240 homes in the noisiest neighborhoods closest to the airport. A second FAA grant received in the fall of 1988 allows for work on an additional 335 homes. Ultimately, approximately 550 dwelling units will be treated under this grant.

Q. What is the most frequently operated aircraft at Logan and is the most common aircraft in the national fleet?

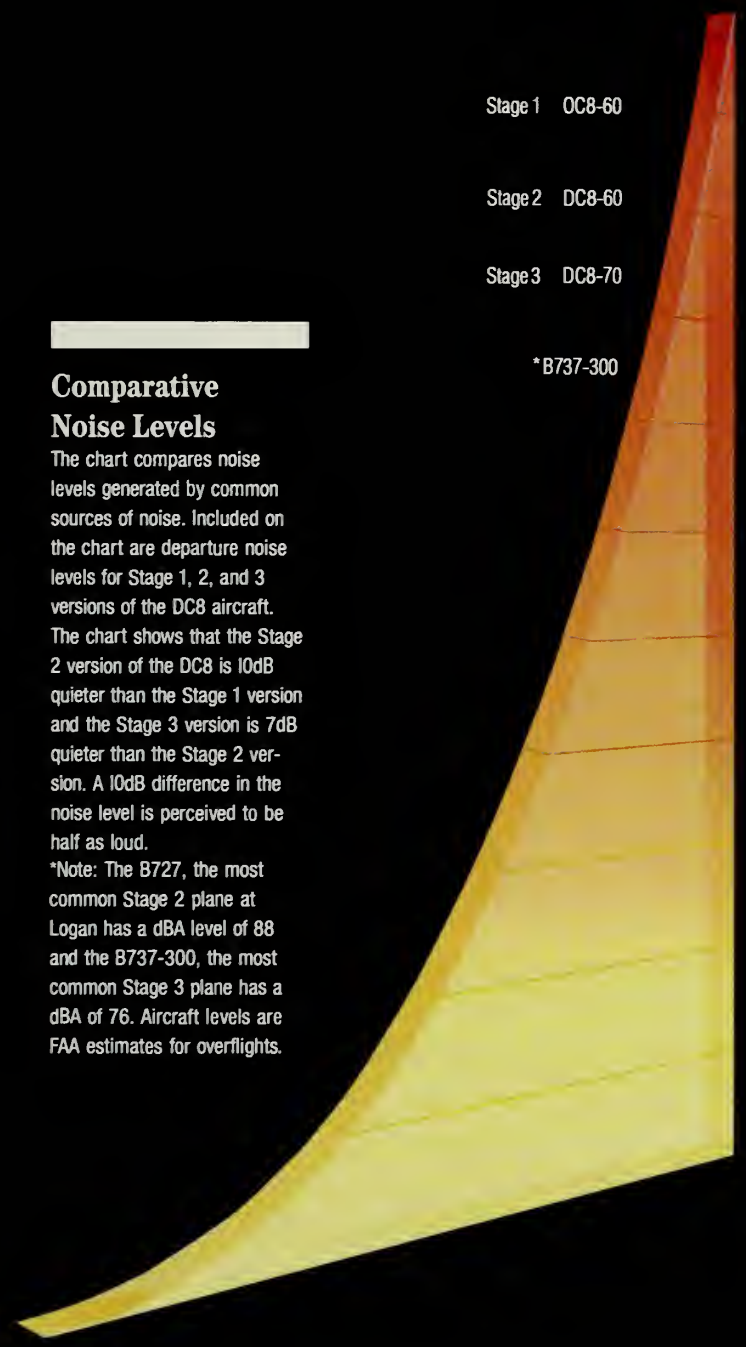
Scaling Down Noise.
While we can compare the difference between a solo violin and a blaring rock band, reduced airport noise is more difficult to define.

We do know that significant differences exist between Stage 2 and Stage 3 jets, as much as 15 decibels (dB) on departure, for example. But what does a 15dB difference in noise level really mean? Put another way, a ten decibel reduction in noise is perceived by the human ear to be about half as loud. The chart on the opposite page puts aircraft noise into context with other commonly understood noises.

Comparative Noise Levels

The chart compares noise levels generated by common sources of noise. Included on the chart are departure noise levels for Stage 1, 2, and 3 versions of the DC8 aircraft. The chart shows that the Stage 2 version of the DC8 is 10dB quieter than the Stage 1 version and the Stage 3 version is 7dB quieter than the Stage 2 version. A 10dB difference in the noise level is perceived to be half as loud.

*Note: The B727, the most common Stage 2 plane at Logan has a dBA level of 88 and the B737-300, the most common Stage 3 plane has a dBA of 76. Aircraft levels are FAA estimates for overflights.



AIRPLANE NOISE LEVELS	COMMON OUTDOOR NOISE LEVELS	NOISE LEVEL dB(A)	COMMON INOOOR NOISE LEVELS
		110	Rock Band
	Jet Flyover at 1000 ft.		
Stage 1 OC8-60		100	Inside Subway Train (New York)
Stage 2 DC8-60	Gas Lawn Mower at 3 ft.		
		90	Food Blender at 3 ft.
Stage 3 DC8-70			
	Noisy Urban Daytime	80	Garbage Disposal at 3 ft.
*B737-300			Shouting at 3 ft.
	Gas Lawn Mower at 100 ft.	70	
			Normal Speech at 3 ft.
		60	
	Quiet Urban Daytime	50	Oishwasher Next Room
		40	
			Library
		30	
	Quiet Urban Nighttime		
		20	
		10	
			Threshold of Hearing
		0	

Monitoring Noise.
With the most sophisticated acoustical system the market has to offer, Massport is entering a new age of noise monitoring. In the next two years, Massport will install 36 remote microphones around Logan and Hanscom Field. The system will provide Massport staff with the ability to record and analyze airport/aircraft noise in new and better ways.

The Airport Noise Monitoring System (ANMS) will monitor noise impacts by time of day, season and on an annual basis. It will also monitor noise levels generated by a variety of aircraft activities including taxiing operations, ground operations, reverse thrust, takeoffs and overflights. Furthermore, it will obtain accurate data on aircraft flight tracks and fleet mix for use in the generation of noise contours and for assessing noise impacts.

The ability to use characteristics of the sound to discriminate between different aircraft events is a unique feature of the Massport system. No other system in the country has the ability to store and evaluate information like this one. It was tailor-made for the noise problems around Logan, another affirmation of Massport's commitment to do the best it can for Logan's neighbors.

Working Toward a Quieter Future.
With resources such as colleges and universities, hospitals and labs, and a thriving service and high tech industry, Massachusetts has a bright future.

That means a busier airport, but, as we've shown here, it won't mean a noisier airport: Massport will continue to balance regional economic needs with local environmental concerns. By strict enforcement of Logan's noise rules, and by continued work on home and school soundproofing, Massport is working toward a quieter future.

Q. What is the largest aircraft that is operated at Logan?

Logan Noise Monitoring System

The map shows the approximate location of the twenty-nine remote noise monitoring stations that will be part of the Logan Noise Monitoring System. Not shown on this map are the seven additional stations that will be installed around Hanscom Field.

NPSI by Aircraft Type

Each aircraft type at Logan is ranked according to its respective average NPSI value. While one version of the B757 has the lowest NPSI, by averaging for all versions of each aircraft type, the MD80 has the lowest average level overall.

Name AC-Type	Average NPSI	Average Seats	FAA Stage	Number of Engines
MD80	70.57	147	3	2
B757	71.43	186	3	2
DC8-70	73.74	200	3	4
L-1011	75.30	287	3	3
B737-300	75.31	131	3	2
B767	75.67	214	3	2
A300	76.00	258	3	2
DC9-30	76.60	109	2	2
BAC-111	77.13	79	2	2
DC10	78.04	263	3	3
B727-200	78.67	152	2	3
B727-100	78.88	115	2	3
B747-300	79.21	384	3	4
DC9-50	79.58	122	2	2
B737	79.69	113	2	2
F-28	80.39	72	2	2
B747	80.58	365	2	4
B707	82.10	224	2	4
DC9-10	82.69	60	2	2
DC8-60	82.69	244	2	4

dB
The decibel (dB) is the unit used to measure the magnitude or intensity of sound. Decibel means 1/10 of Bel (named after Alexander Graham Bell). The decibel uses a logarithmic scale to cover the very large range of sound pressures that can be heard by the human ear. Under the decibel unit of measure, a 10 dB increase will be perceived by most people to be a doubling in loudness, i.e. 80 dB seems twice as loud as 70 dB.

dBA
The A-weighted decibel (dBA) is the most common unit used for measuring environmental sound levels. It adjusts, or weights, the frequency components of sound to conform with the normal response of the human ear at conversational levels.

EPNdB
The Effective Perceived Noise Level (EPNdB) is another unit of measure for aircraft noise. It is based on how people judge the annoyance of sounds they hear with corrections for the duration of the event and for pure tones. The Federal Aviation Administration (FAA) uses EPNdB in the certification of large transport planes for Federal noise regulations (FAR Part 36).

Noise Event
A noise event is the measured sound produced by a single source of noise over a particular period of time. An aircraft noise event begins when the sound level of an overflight exceeds a noise threshold and ends when the level drops back down below that threshold.

Peak Level (in dB)
Peak level is the highest level of sound pressure measured during a noise event.

SEL
Single Event Level (in dBA) is computed by converting the total noise energy measured during a noise event to an equivalent dBA level for a single event that would be only one second in duration.

Leq
The equivalent sound level (Leq) is the average noise level in a given period of time (in dB). The Leq can be given for a single noise event, for an hour, a day, a month, a year, or any other stated time period.

Ldn
The day-night average level (Ldn) is the average noise level computed on the basis of a 24-hour period with a 10 dB penalty for sound occurring at night (10 p.m. to 7 a.m.), to account for the greater intrusiveness of sounds at night. (As noted, for many sounds, a 10 dB increase is perceived as being twice as loud.)

Noise Contour
A noise contour is a line on a map which represents equal levels of noise exposure. Massport uses the FAA's computer model, the Integrated Noise Model, to calculate noise contours in intervals of 5 dBA from 65 to 80 Ldn.

Time Above
The Time Above is a measure identifying the number of minutes in a day which exceed a certain noise level. For example, a location may experience 10 minutes a day when the noise level exceeds 65 dBA.

NPSI
The Noise Per Seat Index (NPSI) is an index value used in the Massport Noise Rules to represent total noise emissions per seat for commercial turbojet aircraft operations at Logan. It is based on the total EPNdB for takeoff and landing, as certified by the FAA, divided by (on an energy basis) the number of seats in the aircraft.

NR
The noise reduction (NR) between two areas is the numerical difference, in dBA, of the average sound levels in those areas. This is also a measure of the noise attenuation produced by the construction, such as a wall and window.

The Staff

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Answers to Quiz Questions

Q. This plane has the lowest certified takeoff noise level of any Stage 3 jet.

A. B757

Q. Why was December 31, 1987 an important night at Logan?

A. Because December 31, 1987 was the FAA deadline to convert DC9s from Stage 1 to Stage 2 – making them quieter airplanes.

Q. What aircraft has the lowest average Noise Per Seat Index at Logan?

A. MD80

Q. What is the most common Stage 3 aircraft at Logan?

A. B737-300

Q. What is the most frequently operated aircraft at Logan and is the most common aircraft in the national fleet?

A. B727

Q. What is the largest aircraft that is operated at Logan?

A. B747

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